Half-Life of ^{232}Pu and Excitation Function for the ^{233}U (^{3}He, 4n) ^{232}Pu Reaction

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During our search [1] for the unknown neutron-deficient ^{231}Pu we were also able to obtain an excitation function for the ^{233}U (^{3}He, 4n) ^{232}Pu reaction and to determine an improved half-life for ^{232}Pu.

Results presented here are based on three series of experiments: **(1)** Irradiation of several ^{233}U targets (on average $53.4\ \mu g/cm^2$ on $4.6\ mg/cm^2$ Be-backing) with 30, 36, 42, 48, and 54 MeV $^{3}He^{2+}$-ions and subsequent TTA-extraction of the Pu after a 30 minute collection of reaction products. **(2)** Irradiations with 36-, 42-, and 54-MeV ^{3}He projectiles, where the Pu-fraction was separated via anion exchange. **(3)** As in (1), but the chemical separation was performed by solid phase extraction chromatography.

Projectile energies were corrected for energy loss in multiple targets [2]. Experimental details for the irradiations, including detection system, and data analysis can be found in [1,3]; details of different chemical separations used are described in [4].

After chemical separation of ^{232}Pu, the 9.1-minute ^{228}U daughter approaches transient equilibrium with the ^{232}Pu decay. Other members of the decay chain, with much shorter half-lives, are in secular equilibrium with ^{228}U. Hence, α-α-correlations starting with the granddaughter ^{224}Th were used as the basis for the half-life determination.

The half-life analysis was performed using MLDS [5]. Data were fit as growth and decay of ^{228}U from a ^{232}Pu parent. The half-life of ^{228}U was fixed at 9.1 min, but its initial activity was allowed to vary. Figure 1 shows a decay curve as observed in (3).

Data from the four low-energy irradiations of (1), all of (2), and (3) were used for the half-life determination. (1) gave a ^{232}Pu half-life of 33.5 ± 1.2 min, (2) 31.4 ± 2.0 min, and (3) 33.3 ± 1.1 min. Weighted average of all half-lives yields a ^{232}Pu half-life of 33.1 ± 0.8 min, which is slightly lower than that of 34.1 ± 0.7 min reported by Jäger et al. [6].

Initial activities of ^{232}Pu at time of chemical separation were determined by MLDS using the new ^{232}Pu-half-life and appropiate efficiency corrections.

The cross section data for the ^{233}U(^{3}He, 4n)^{232}Pu reaction shown in Figure 2 indicate a maximum production cross section of 6.2 μb at 32-MeV (laboratory frame), which is one order of magnitude lower than JORPL [7] predicts.

Footnotes and References

[1] C. A. Laue et al., Phys. Rev. **C 59**, 3086 (1999).

[2] F. Hubert et al., At. Data Nucl. Data Tab. **46**, 1 (1990)

[3] C. A. Laue et al., Phys. Rev. **C** accepted Jan 2000

[4] C. A. Laue et al., to be published in Solvent Extr. Ion Exch. **18**, v3 (2000).

[5] K. E. Gregorich, Nucl. Instrum. Meth. **A 302**, 135 (1991).

[6] U. Jäger et al., Z. Phys. **258**, 337 (1973).

[7] J. Alonso, *Gmelins HB Anorg. Chem*, Weinheim, Germany, Bd 7b Part A1, 1973.

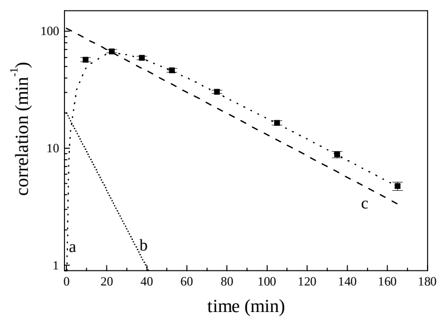

Figure 1: Decay-curve fit (MLDS) for ^{232}Pu half-life determination. (■) observed growth and decay data measured for ^{228}U (^{232}Pu-daughter); (a) fit to growth and decay of ^{228}U from ^{232}Pu α-decay; (b) fit to decay curve of ^{228}U initially present in Pu fraction; and (c) overall fit to ^{232}Pu-decay curve.

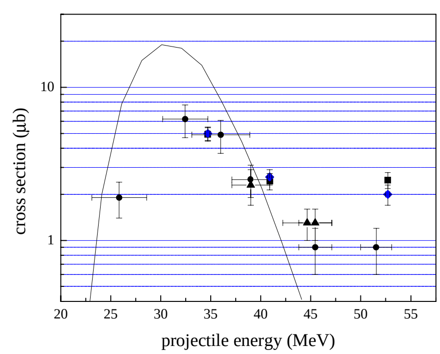

Figure 2: Excitation function for the ^{233}U (^{3}He, 4n) ^{232}Pu reaction. Symbols represent cross sections from: (●) series (1) α-α-correlations, (◆) series (2) singles α-spectra, (■) series (2) α-α-correlations (▲) series (3) α-α-correlations, and (line) JORPL calculations.